WAAS and LAAS Program Status

Deborah Lawrence
FAA WAAS Ground Segment Development Lead

Federal Aviation Administration

FAA's GNSS Activities

- **U.S. Has Approved Use of Global Positioning System (GPS) For Aircraft Navigation For Over A Decade**
- **FAA Working With Other U.S. Federal Government Agencies To Ensure Modernization of GPS Improves Aviation Capabilities**
- **FAA Has Commissioned the FAA's GNSS Space Based Augmentation System (SBAS)**
  - Wide Area Augmentation System (WAAS)
- **FAA Is Continuing Development Of the GNSS Ground Based Augmentation System (GBAS)**
  - Local Area Augmentation System (LAAS)
- **FAA Has Committed To A "Performance Based National Airspace System"**
  - Fully utilize the capabilities of all equipment aboard the aircraft
  - Implement Required Navigation Performance (RNP)

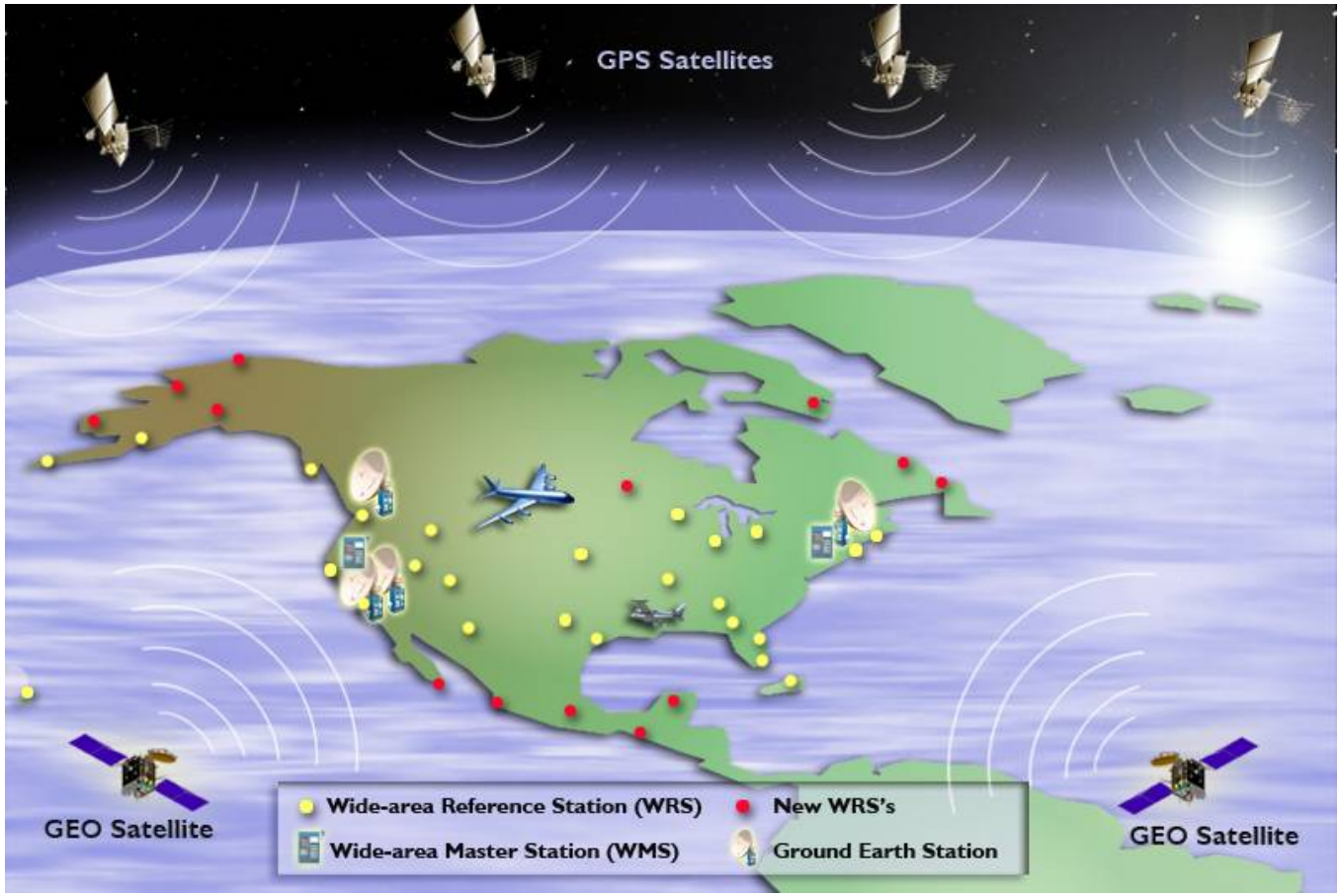
WAAS

- **Enhances Navigation In All Phases Of Flight**
  - Enroute, Arrival, and Departure:
    - Provides 100% Availability Of GNSS For Even The Most Critical RNP or RNAV Operations
    - Provides Coverage At All Altitudes From 100,000 Feet To The Surface
    - Provides Navigation Services To Users That Are Not Currently Served
  - Approach:
    - Enhances Safety By Providing Vertical Guidance To Every Runway End In The Coverage Area
    - No Ground Hardware Required At Airport
    - Allows IFR Operations To All Qualified Airports

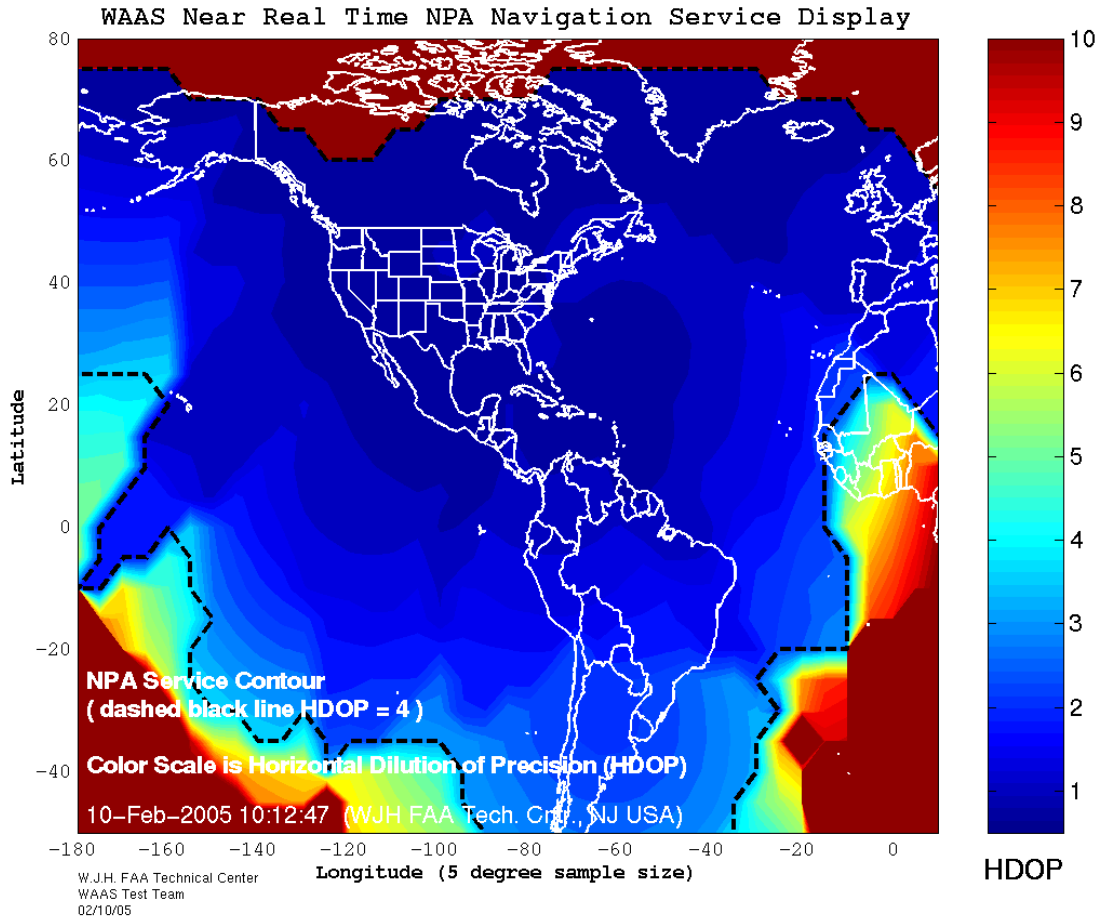
WAAS Background

- **August 2000: FAA Makes WAAS Available For Non IFR Aviation Use**
  - Signal Available At Surface For All Users
- **July 2003: Initial Operating Capability (IOC) For All Aircraft Instrument Flight Rule Use**
  - 100% Coverage CONUS & Alaska From 100,000 Ft. To Surface
  - Horizontal Accuracy 1.5M
  - Vertical Accuracy 3M
  - Better Than 99.999% Availability Of System
  - 95% Availability In CONUS Of Instrument Approaches With Vertical Guidance
    - Enhances safety
    - 250 foot Decision Height / ¾ Mile Visibility minimums
    - No ground hardware required
    - Instrument approach procedure required for each runway end

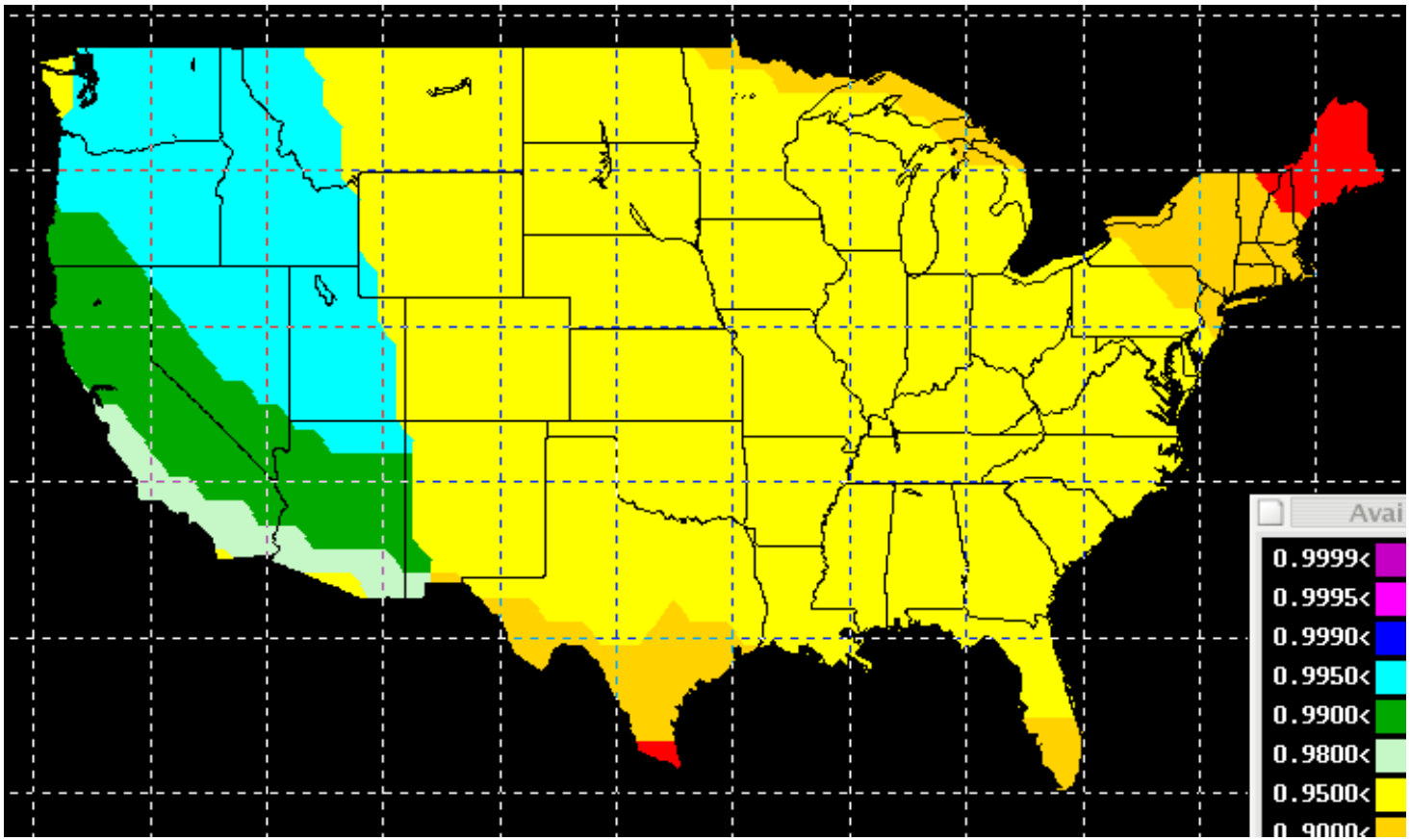
WAAS Architecture



Area Navigation Availability



Current LPV Approach Availability



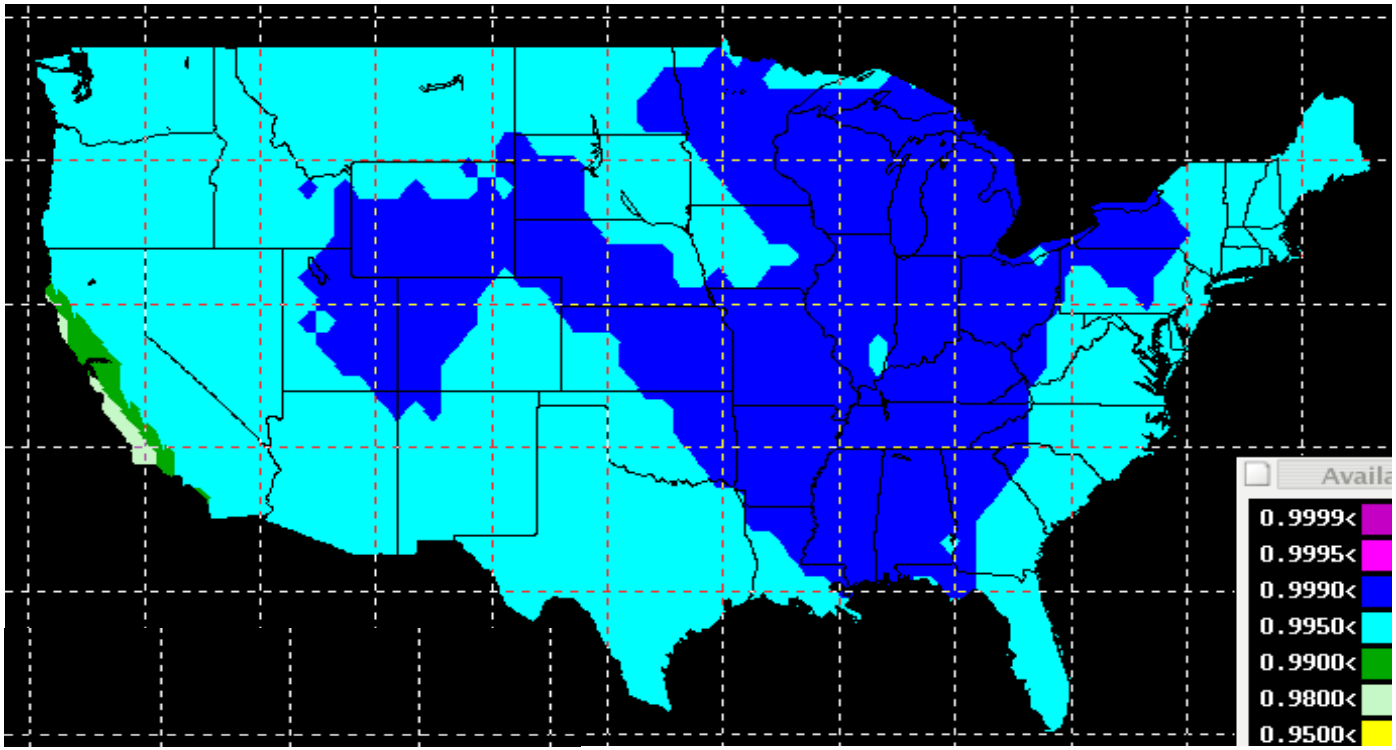
WAAS Development Schedule

- **Development Will Continue In Two Segments** **2003-2008**
  - LPV Segment
  - GLS Segment
- **Improvements To Ground Components To Complete "LPV Segment"**
  - Software Efficiency Improvements, Integrity Monitor Improvements, And Additional Ground Reference Stations Will Be Brought Online Incrementally
  - End State Performance Will Result In Greater Availability Of Approach With Vertical Guidance (LPV – 250ft Minimums)
    - 99% Continental United States
    - 95% In Most Of Alaska
- **Addition of GEO Satellites To Provide At Least Two In View To All Users Over All CONUS And Alaska** **2007**
- **Improvements To Ground Components To Complete "GLS Segment"** **2008 -2013**
  - Requires GPS Modernization – L5 Frequency
    - WAAS 200' Minimums (First WAAS Precision Approach)
  - Requires Hardware And Software Modifications

Development Activities: LPV

- **Hardware**
  - 13 Additional Wide Area Reference Stations To Improve Availability And Coverage
    - 4 Alaska
    - 5 Mexico
    - 4 Canada
    - Equipment Upgrade Using Commercial Off The Shelf Hardware When Feasible
- **Communications**
  - Enhancing The Terrestrial Communications Network
- **Software**
  - More Efficient Integrity Monitor Algorithms
  - Enhanced O&M Efficiency
- **Prime Contractor - Raytheon**

Predicted LPV Availability
2008 Full LPV Capability



Regional Cooperation

North American WAAS

- **USA, Canada, and Mexico Are Working Through The North American Aviation Trilateral (NAAT) Regional Cooperation Meeting On Civil Aviation Safety, Security, Capacity, And Efficiency To Cooperate On The Implementation of GNSS In The North American Region**
- **Canada And Mexico Will Host Additional Reference Stations To WAAS System**
  - 5 Mexico
  - 4 Canada
- **Provides WAAS Coverage In Canada And Mexico**
- **Improves Availability For U.S.**

Canada

- **Installing Four Reference Stations**
  - Goose Bay
  - Gander
  - Iqaluit
  - Winnipeg
- **Site Surveys Complete**
- **First Site Installed in Gander, Goose Bay to be Installed This Month**
- **Second Set of Sites to Be Installed In August 2006**
- **Sites Scheduled to Be Operational In 2007**

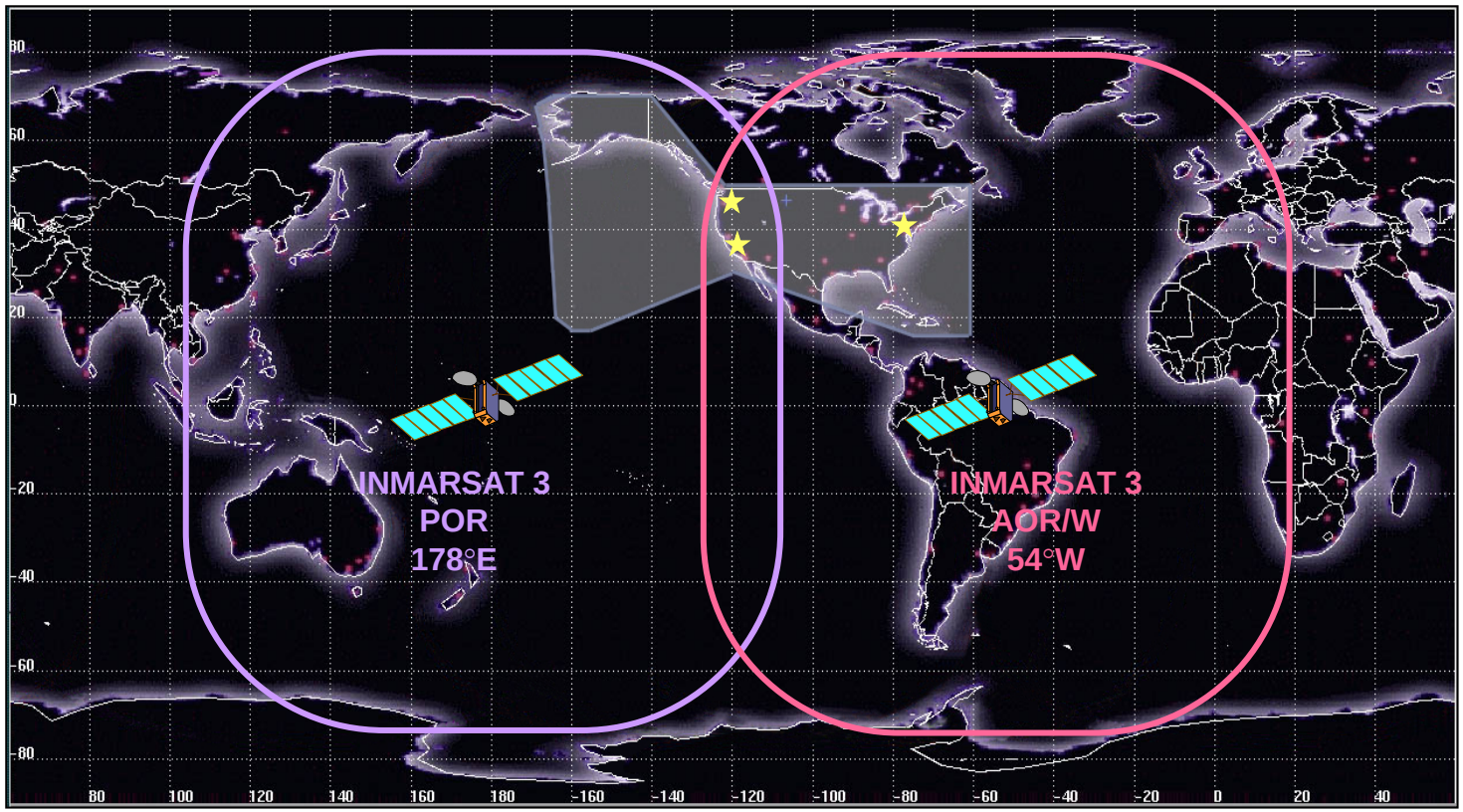
Mexico

- **Installing Five Reference Stations**
  - Mexico City
  - Merida
  - Puerto Vallarta
  - La Paz
  - Tapachula
- **Mexico City Installed In August, Merida and Puerto Vallarta to be Installed In October**
- **Second Set to be Installed Next Summer**
- **Sites Scheduled to Be Operational In 2007**

INMARSAT III

- **Current INMARSAT Lease Extended to July 2007**
- **INMARSAT AOR-W Scheduled To Be Relocated From 54W To 98W In January 2006**
  - Medium Risk To WAAS Users In CONUS
  - WAAS Team Performing Trade Study On Mitigation Options
    - Decision Made to Continue Transmitting WAAS Signal Minus Ranging

Current GEO Service
Inmarsat III



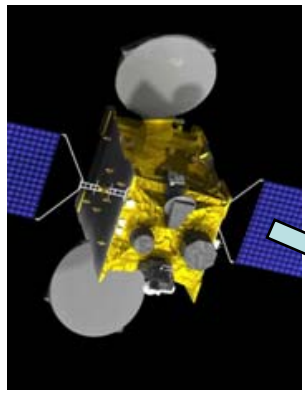
- **Main Problem Is Single Coverage Over the Majority of CONUS**

GEO Satellite Improvements

- **Lockheed Martin Prime Contractor**
- **Contract Definitization Completed March 2005**
- **Contract Structured to Provide:**
  - Leased Payloads on Up to 3 Satellites
  - Ground Infrastructure to Support Signal in Space
- **Goal is Two GEOs In View To All Users Over CONUS and Alaska by 2007**

Telesat Anik F1R at 107°W

- **Telesat Canada Anik F1R**
  - Satellite Payload Integration Complete
  - Satellite Completed Thermal Vacuum Testing
  - Satellite Launched September 8, 2005
- **Ground Uplink Stations**
  - Site Installations Scheduled For October 2005, Brewster, WA And Woodbyne, MD
- **Operational October 2006**



PanAmSat at 133W

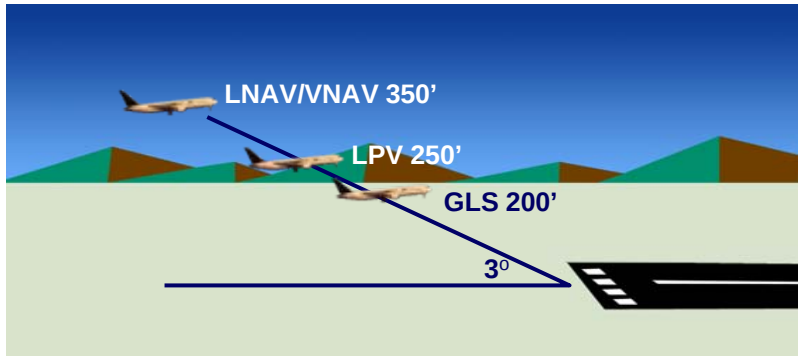
- **Ground uplink stations**
  - Signal generator subsystem (SGS) factory acceptance tests complete
  - Radio frequency unit (RFU) installations complete, Napa CA and Littleton, CO
  - SGS/RFU integration complete in Napa
- **PanAmSat galaxy XV**
  - Satellite payload integration complete
  - Shipped to launch site
  - Scheduled to Launch September 29th
- **Operational Early 2007**

WAAS Avionics

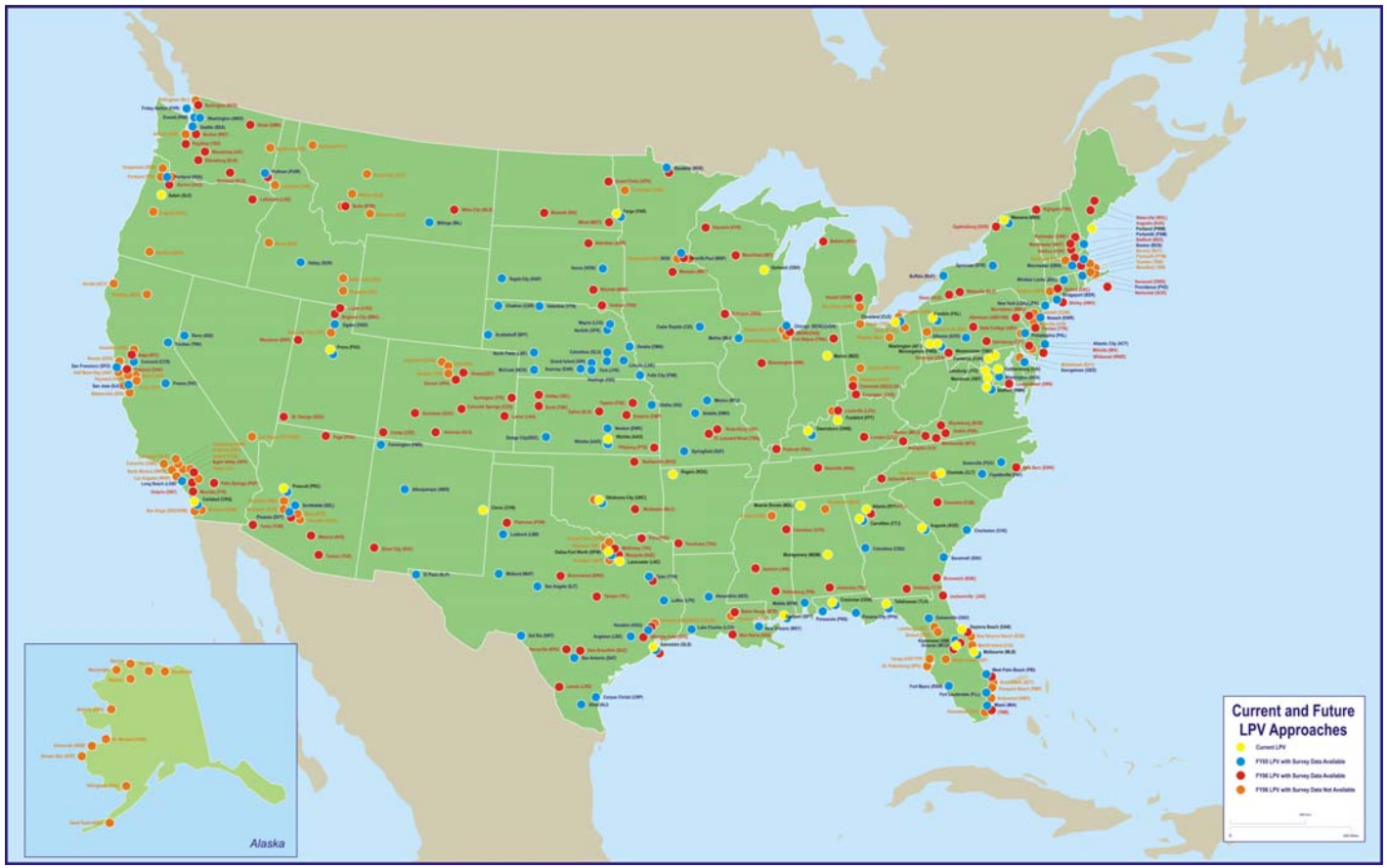
- **Two Certified Receivers Currently Available**
  - Garmin & Chelton Systems (With Free Flight Systems WAAS Sensor)
  - Over 4,000 Garmin GNS-480 Sold
- **In Development**
  - Garmin 430/530 Upgrade – Available Summer 2006
    - 50,000 units eligible for upgrade
  - Chelton, Universal, Thales, and Honeywell expect to have units available in 2006
- **FAA Funding Development of Rockwell Collins Unit**
  - Supports FMS and regional jets
  - Available November 2006
- **Others in Development**

Operational Implementation

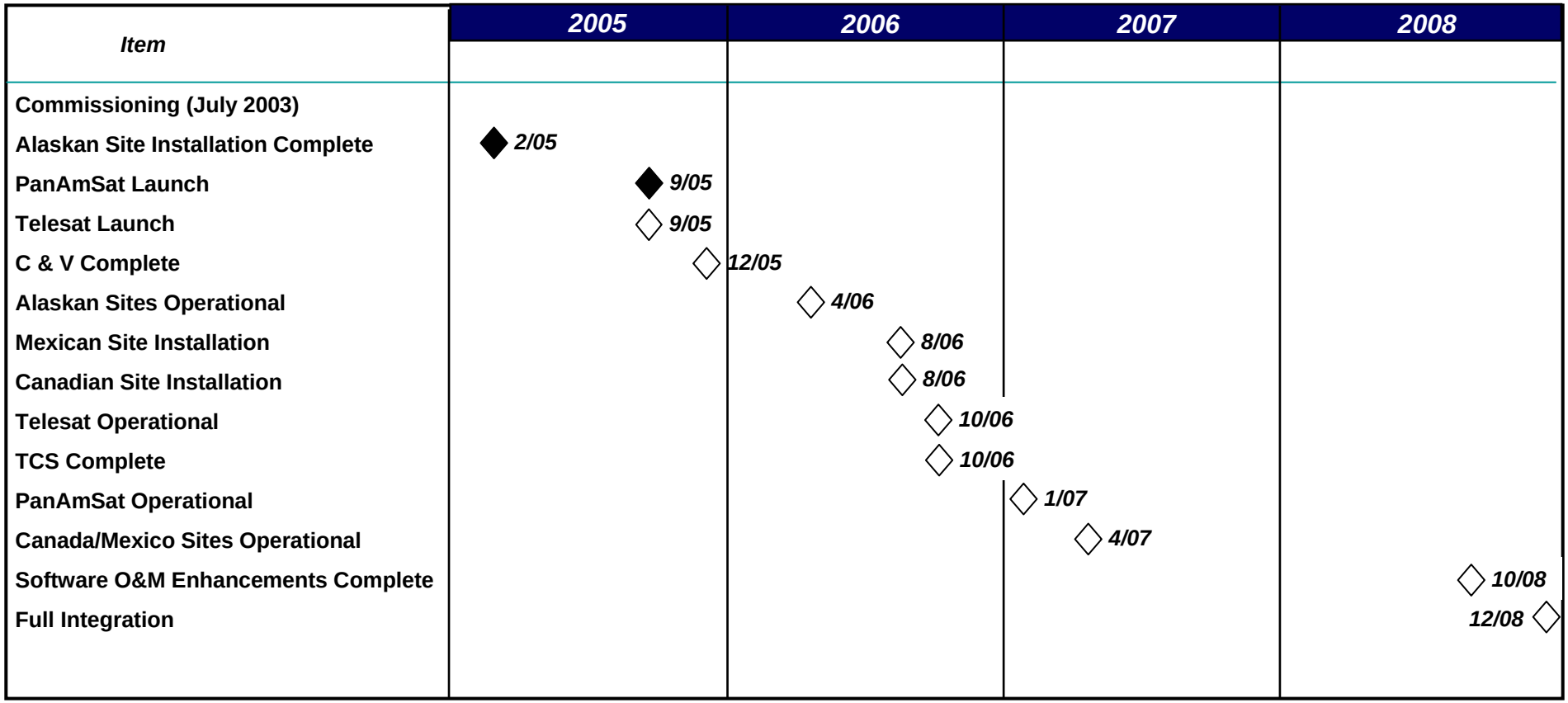
- **Existing Procedures:**
  - 240 LPVs
    - 104 at non-ILS Runway Ends
  - 739 LNAV/VNAV
  - 3,670 LNAV/GPS
- **Procedure Production**
  - FY 06
    - 341 Procedures Planned
    - 258 Are at Non-ILS Runways
    - 210 Provide Capability at Airports Where No Precision Approach Existed



Current and Future LPV Approaches



WAAS Schedule



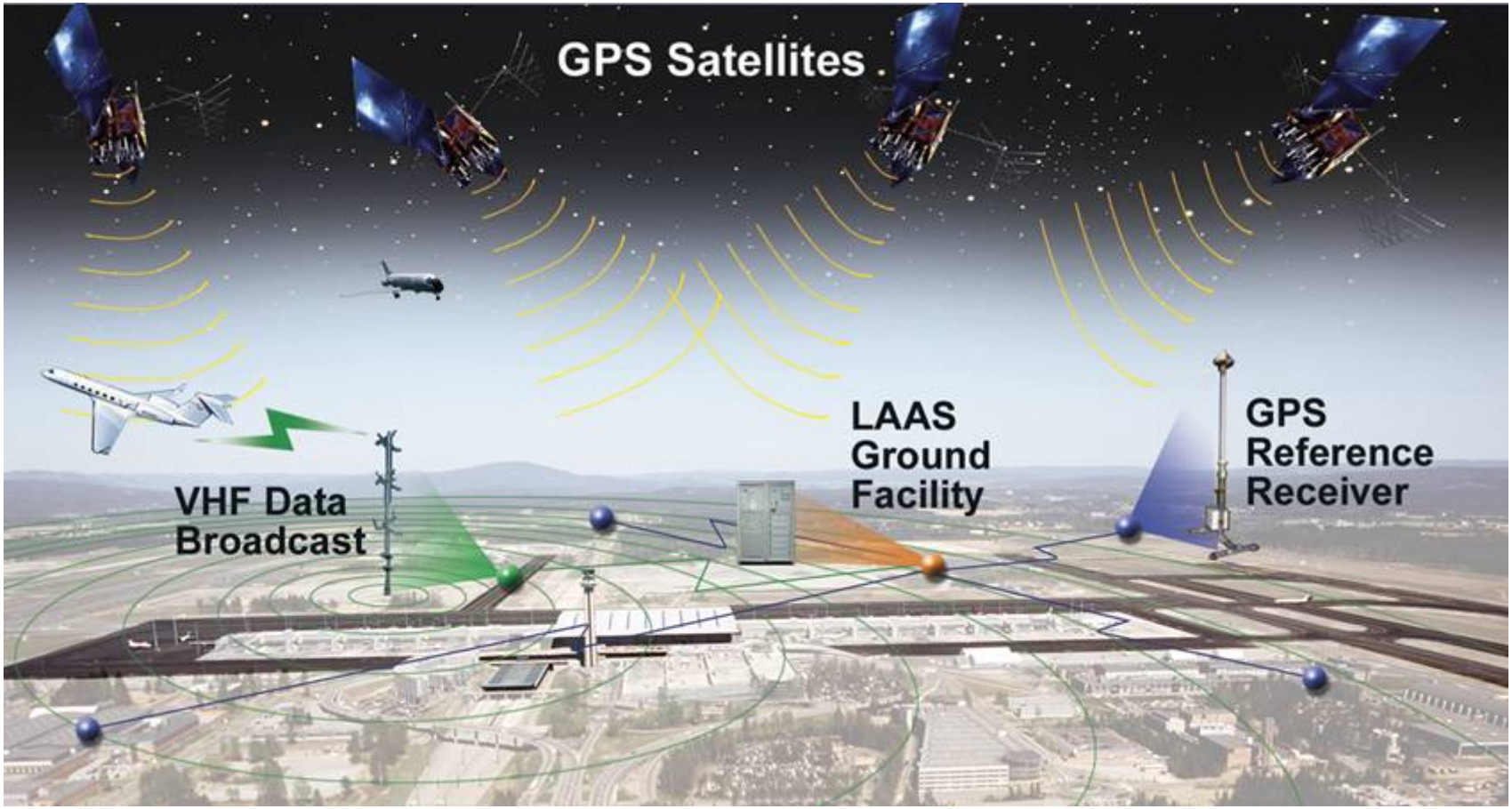
Potential WAAS Civil Applications

- Agriculture
- Aviation
- Maritime
- Highway
- Railroad
- Precision Timing
- Mining/Geology
- Surveying
- Banking
- Remote Sensing
- Power
- Telecommunications
- Law Enforcement
- Emergency
- Disaster Response
- Weather
- Construction
- Recreation
- Environmental Mgmt
- Mapping/Geodesy

Current WAAS/SBAS Civil Applications

- Agricultural
- Marine
- Outdoor Recreation
- Surveying
- Emergency
- Millions of Civil Users Today

GBAS (LAAS) Architecture



LAAS Capabilities

- **The Local Area Augmentation System (LAAS) Represents the U.S. Approach to the International Goal of an Interoperable GBAS Capability**
- **LAAS Provides a Navigation Signal That Supports the Most Demanding RNP Requirements**
- **LAAS Provides Service Beyond SBAS Limitations**
- **One LAAS Can Cover the Entire Terminal Area and Enables Precision Guidance**
  - All Runway Ends
  - Multiple Landing Points
  - Surface Movements

Background

- **Program Baseline Completed in 1999**
  - Government Industry Partnership For Category-I
  - Category-III Full Scale Development Planned to Leverage Experience From GIP
- **GIP Experienced Delays Due to Integrity Issues**
- **In 2001, Strategy Changed To Full Scale Development Contract for Category-I LAAS**
- **Contract Awarded To Honeywell In April 2003**
  - Aggressive Schedule and Integrity Issues Resulted In Delays
  - Recovery Plan Completed In January 2004
- **FAA Directed Program Back To R&D In February 2004**
  - Lower Overall Program Risk, Resolve Integrity Issues
  - Complete Benefits Assessment
  - LAAS Budget Request Zeroed for FY05-09
- **Honeywell Contract Re-Planned To Resolve Integrity Risks**
  - Restructure LAAS Integrity Panel & Develop Provably Safe Prototype

Honeywell Contract

- **Work In-Process**
  - Develop New “Proveably Safe” Integrity Algorithms
  - Implement Software in Existing Beta-LAAS in 3 Builds
  - Add Memory to Differential Correction Processors (DCPs)
  - Upgrades to GPS Reference Receivers and High Zenith/Multipath Limiting Antennas
  - Addition of 4th GPS Reference Receiver and Antenna
  - Re-Siting of GPS Reference Receivers to FAA Installation Guidelines
  - Develop Preliminary System Safety Assessment Report

Summary

- Benefits All Classes Of Aviation Users
- Commissioned For IFR Use On July 10, 2003
- Signal Enhances Navigation In All Phases Of Flight
- WAAS Enhances RNP And Performance Based NAS
- Enhances Safety And Efficiency Of NAS
- Aviation Receivers Available Today, More Coming To Market Over Next Three Years
- Will Be Improved Incrementally To Bring Added Capability Online As Soon As It Is Ready
- Demonstrates FAA Commitment To Improving Services For All Aviation Users

FAA’s GPS Website: http://gps.faa.gov

Backup Slides

WAAS – GLS Development

- **Commencing In 2008**
- **GLS Capability Will Require Modernized GPS Constellation**
  - Addition Of Second Frequency, L5
  - Availability Of L5 For Operational Use By Aviation Expected By 2013
  - FAA Ground Upgrade Complete In 2013
- **Hardware:**
  - Upgrade of Reference Station Receivers To Receive L5
- **Software:**
  - Broadcast Of WAAS Message On L5
- **Eliminates Loss Of Vertical Guidance Caused By Ionospheric Storms**
- **Provides Full GLS Capability Throughout Coverage Area**
- **Capable Of Augmenting Other Satellite Navigation System Constellations**

Why Support Cat-I GBAS

- **Next Step On The Pathway to Category-III GBAS**
  - Lessons Learned During Cat-I Development are Applicable for Cat-III
  - Cat-III Requirements May Not Be As Stringent As Originally Envisioned
- **International Leadership**
  - Other Service Providers and DoD Have a Need For Cat-I
  - FAA May Leverage Foreign Investment in US Technology to Achieve Cat-I Capability
- **Industry Support**
  - FEDEX Has Requested Support and Intends to Submit an Application For Approval for Memphis
- **DoD SATNAV Strategy**
  - The HI Cat-I LAAS May Satisfy DoD JPALS Increment # 1 for Land-Based Systems
  - DoD Has Followed GNSS Path Similar to Civil Aviation Community
  - Use of Standalone GPS and GBAS

GBAS International Working Group

- **International GBAS Working Group established by European Service Providers, EUROCONTROL and Industry**
- **International Service Providers Need Category-I GBAS**
  - "Airservices Australia", AENA/Spain, and DFS/Germany Already Have Contracts With Honeywell
- **Boeing & Airbus Have Joined Forces in Support of GBAS**
  - Boeing B-737NG Certified With GBAS Avionics (Qantas)
  - Airbus A-380 To Be Certified
- **International GBAS Development Activities**
  - "Airservices Australia" Intends to Leverage FAA's Investment in GBAS Technology
    - Establish a Honeywell Contract To Complete Implementation of FAA "Provably Safe Prototype" in Sydney
  - Germany & Spain Interested in Investing in HI Beta-LAAS Upgrades in Parallel With FAA/Australia Activities in Bremen & Malaga
  - FAA Technical Support Needed for the Approval
    - Establish Memorandum of Cooperation (MOC) Agreements With Interested Service Providers
  - Opportunity for FAA to Leverage "Airservices Australia" Investment

Activities and Outlook

- **Continue R&D Activities to Resolve Integrity Issues Through FY2006**
  - LAAS Integrity Panel (LIP) Process to Resolve All Remaining Key Integrity Risks to Low/Medium
- **Investigate a Simplified LAAS Architecture**
- **Prepare an RFI Analysis of GPS-Based Landing Systems**
- **Establish Business Case**
- **Support International GBAS Development Activities**
  - Support GBAS International Working Group Information Exchange, Studies and Research Activities
  - Support Other Service Providers Intent to Leverage FAA's Investment in GBAS Technology
  - Establish Memorandum of Cooperation (MOC) Agreements With Interested Service Providers
  - Investigate Potential for Completing Regulatory Approval of Honeywell Beta-LAAS in Memphis